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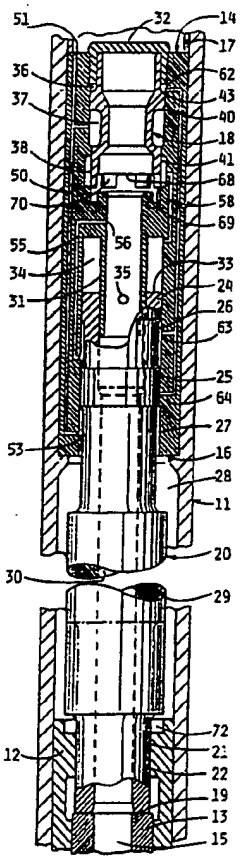
(54) Title: HYDRAULIC DOWN-THE-HOLE ROCK DRILL

(57) Abstract

A hydraulic down-the-hole rock drill is adapted to be driven by pressure water. The spent drive fluid is utilised as a flushing medium to flush the debris out of the borehole. The piston hammer (20) is guided at its front and rear ends and a continuously pressurized chamber (28) extends around the piston hammer all the way between the two guiding portions (22, 27). The front guiding portion (22) has a smaller diameter than the rear guiding portion (27) so that the piston hammer will have a differential piston area in the chamber (28). Thus, the pressure in the chamber (28) will provide a continuous force backwards on the piston hammer and cause the return stroke of the piston hammer when a valve controlled cylinder chamber (34) at the rear end of the piston hammer is depressurized.



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Hydraulic down-the-hole rock drill

This invention relates to a hydraulic down-the -hole rock drill comprising a housing arranged to be mounted to the front end of a drill tube, a drill bit slidably received and retained by the front end of the housing and having a channel extending longitudinally therethrough, a head at the rear end of the housing, a port in said head arranged to be supplied with pressurized hydraulic fluid from said drill tube, a piston hammer arranged to repetitively impact on said drill bit and having a a longitudinal channel therethrough, a control valve in said head, a flushing fluid channel extending from said valve to the front end of said drill bit and including said channels in the piston hammmer and in the drill bit, said piston hammer having a first piston surface in a first pressure chamber to drive the piston hammer forwardly when said first pressure chamber is pressurized, a second piston surface in a second pressure chamber arranged to drive the piston hammer rearwardly when said first chamber is depressurized, said valve being arranged to alternately connect said first pressure chamber to said port and to said flushing fluid channel so as to reciprocate the piston hammer.

Such a hydraulic down-the-hole rock drill, in which the spent drive fluid is used as a flushing medium,is described in applicant's WO89/00638 which is the closest prior art.

It is an object of the invention to improve the power efficiency of a rock drill of the kind specified and to extend its expected life.

The invention will be described with reference to the accompanying drawings which show an embodiment of the invention.
Fig 1 is a longitudinal view through a hydraulic down-the-hole rock drill.
Fig 2 is a view corresponding to Fig1, but it shows some details in other relative positions.

The drill shown in the figures has a tubular housing 11. A sleeve-like insert 12 is fixed to the front end of the housing 11 by means of threads. It forms a holder for a drill bit 13. Since the drill bit and the way it is retained in its holder are conventional, only the r ar end of the drill bit, the shank, is shown.

The drill bit 13 is axially slidable in its holder a limited distance and it is shown in its rear end position in which it is during drilling. The drill bit 13 is locked against rotation to the housing 11 in a conventional way. A central flushing fluid passage 15 leads from the annular rear end surface 19, the impact surface, of the drill bit shank to the front end of the drill bit

At the rear end of the housing 11, there is also a sleeve-like insert 14.This insert 14 is axially clamped between a shoulder 16 in the housing 11 and a spacer sleeve 17 by means of a non-illustrated sub that is threaded to the housing and has threads by means of which it can be fixed to the lower end of a drill pipe. The insert 14 forms a head in the upper end of the housing 11 and it forms a housing for a tubular valving element 18.

A piston hammer 20 has a front end 21 sealingly guided in a cylindrical guiding portion 22 of the front insert 12 and a rear end 24-26 sealingly guided in a cylindrical guiding portion 27 of the rear insert 14.The rear guided portion 24-26 of the piston hammer 11 has a control groove 26 so that it comprises two lands 24,25. A chamber 28 extends axially between the two piston guiding portions 22,27.Thus the major part of the length of the piston hammer 20 runs freely without contact with the housing. In a drill with an outer diameter of 100 mm, the piston can be 500 mm long and the distance between the two guiding portions 22,27 can be 400 mm. As shown, the major length of the piston hammer 20 can have a greater diameter than its guided portions 21 and 23,24 respectively,this enlarged major portion has been given the reference numeral 29. The diameter of the rear guiding portion 27 is greater than the diameter of the front guiding portion 22 which provides for a differential piston area of the piston hammer in the chamber 28 so that the pressure in the chamber 28,which is permanently prevailing as will be described later,will cause a continuous upward directed force on the piston hammer.

The piston has a central longitudinal channel 30 that is coaxial with the channel 15 in the drill bit 13.The rear insert 14 has a central tube 31 that protrudes into the channel 30 in the piston with a sliding fit and the valving element 18 is located at the rear of the tube 31 and it is coaxial with the

tube.The back end of the insert 14 has a cap 32 so that the flushing fluid channel 15 in the drill bit extends straight all the way back to the cap 32 through the interior of the sleeve-like valving element 18. The annular rear end surface 33 of the piston hammer 20 is in a cylinder chamber 34.The piston area of this piston surface 33 is greater than the differential piston area of the piston hammer located in the chamber 28; it is several times greater for example four times greater.The tube 31 has a number of holes 35 that are normally blocked.

The valving element 18 and its housing form three chambers 36,37,38.The valving element 18 has a sliding surface 40 above the chamber 37 and a sliding surface 41 below the chamber 37. The diameter of the sliding surface 40 is greater than the diameter of the sliding surface 41 so that a differential piston area is provided that gives an upward directed differential force on the valving element 18 when the chamber 37 is pressurized.This differential piston area is however smaller than the annular piston surface 43 that is in the chamber 36 and gives a downward force when the chamber 36 is pressurized.

In the rear insert 14, there is a supply passage 50 that has a port 51 to the sub,that is to the interior of the drill tube,a port 52 to the chamber 37, and a port 53 to the chamber 28. A passage 55 extends between two ports 56,57,that is,the passage 55 is always open to the flushing fluid channel 15,30,31. A passage 58 connects the two chambers 34 and 38. A control passage 61 for shifting the position of the valving element has a port 62 into the chamber 36 and control ports 63,64.

The valving element has two positions;a rear position shown in Fig 1 in which it opens the chamber 38 to the tube 31 and a forward position shown in Fig 2 in which it opens the chamber 37 to the chamber 38. The valving element has a valving edge 68 that cooperates with an edge 69 in the valve housing. A number of teeth 70 extend beyond the valving edge 68 so as to define the forward position of the valving element shown in Fig 2 in which the edges 68 and 69 overlap.

The operation of the drill will now be described.

The non-illustrated drill pipe transmits rotation and a feed force to the drill housing 11. The feed force is transmitted from the drill housing 11 to the drillbit which co-rotates with the housing 11. Drive fluid,that is, water under pressure, is supplied through the drill pipe and the supply passage 50 is continuously pressurized through its port 51. Thus, the chambers 37 and 28 are continuously pressurized. In Fig 1, the piston hammer 20 is in its position of impacting on the drill bit 13. During the forward hammering stroke that the piston just ended, the valving element 18 was in its position shown in Fig 2 since the control passage was pressurized, but, during the hammering stroke, the port 63 of the control passage 61 is opened to the control groove 26, the port 64 is blocked by the land 25 of the piston hammer and when the port 57 of the drain passage 55 is opened to the control groove 26 the control passage 61 drains the control chamber 36 so that the pressure in the chambers 37,38 moves the valving element 18 upwards so that the cylinder chamber 34 at the rear of the piston hammer is drained. As a result, the pressure in the chamber 28 moves the piston hammer backwards.Then, during the upward return stroke of the hammer piston, the drain port 57 is blocked by the land 25, and the control port 64 is opened to the chamber 28 so that the control passage 61 pressurizes the chamber 36.As a result, the valving element moves to its forward position shown in Fig 2 in which it pressurizes the cylinder chamber 34 so that the piston hammer turns and starts its forward work stroke.

Drilling is interrupted automatically when the drill housing 11 is lifted by means of the drill pipe since the drill bit 13 and the piston hammer will move forwardly relative to the housing. The piston hammer will move into a damping chamber 72 so that the holes 35 will be unblocked and supply an intensive flow of water to the flushing fluid passage 15,30,31.

At its rear end, the piston hammer 20 is guided along its two lands 24,25 and at its front end, it is guided along the length of the guiding portion 22. Thus, more than half of its length is located between its short guiding lengths which makes it possible to have close tolerances in the guidings so that the leakage is minimized and still the expected life of the drill will be long.It is not necessary to have any lubricating additives to the drive water.

The supply passage 50 and the drain passage 58 are shown as single passages.It should be understood that they are multiplied in order to provide for sufficient flow.All the supply passages 50 and drain passages 58, and the passages 61,65 for controlling the valve 18 are located in the rear insert 14.

The drill can be used not only for drilling downward directed holes but it can be used in all directions. Thus, it can even be used to drill upward directed vertical holes.

CLAIMS

1.A hydraulic down-the-hole rock drill comprising a housing (11) arranged to be mounted to the front end of a drill pipe, a drill bit (13) slidably received and retained by the front end of the housing and having a channel (15) extending longitudinally therethrough, a head (14) at the rear end of the housing, a port (51) in said head arranged to be supplied with pressurized hydraulic fluid from said drill tube, a piston hammer (20) arranged to repetitively impact on said drill bit and having a a longitudinal channel (30) therethrough, a control valve (18) in said head, a flushing fluid channel (15,30,31) extending from said valve to the front end of said drill bit and including said channels in the piston hammmer and in the drill bit, said piston hammer (20) having a first piston area (33) in a first pressure chamber (34) to drive the piston hammer forwardly when said first pressure chamber is pressurized, a second piston area in a second pressure chamber (28) arranged to drive the piston hammer rearwardly when said first chamber (34) is depressurized, said valve (18) being arranged to alternately connect said first pressure chamber (34) to said port (51) and to said flushing fluid channel (15,30,31) so as to reciprocate the piston hammer,
characterized in that
said second chamber (28) is in continuous communication with a port (51) that is arranged to be supplied with pressurized hydraulic fluid from the drill pipe and extends around the piston hammer (20) all the way between the front and rear guiding portions (22,27), said front guiding portion (22) having smaller a diameter than the rear guiding portion (27) so as to provide for said second piston area.

2.A drill according to claim 1, characterized in that at least 2/3 of the length of the piston hammer (20) is unguided and located in said second chamber (28).

3.A drill according to claim 2, characterized in that at least half the length of the piston hammer (20) is diametrically enlarged as compared with its guided portions.

FIG 1

1/1

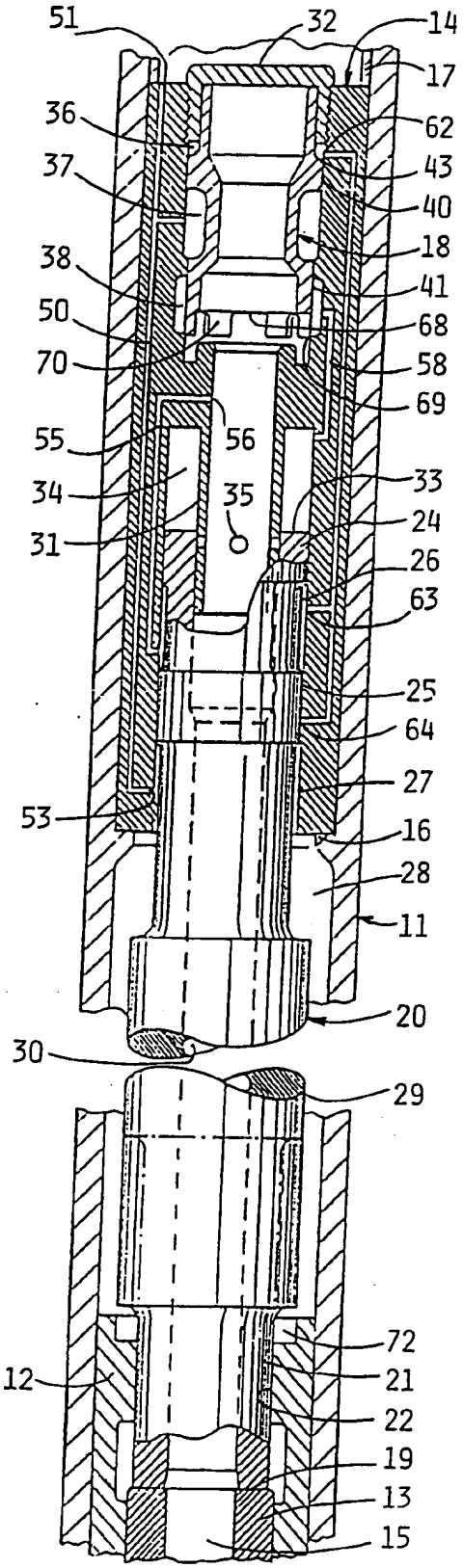
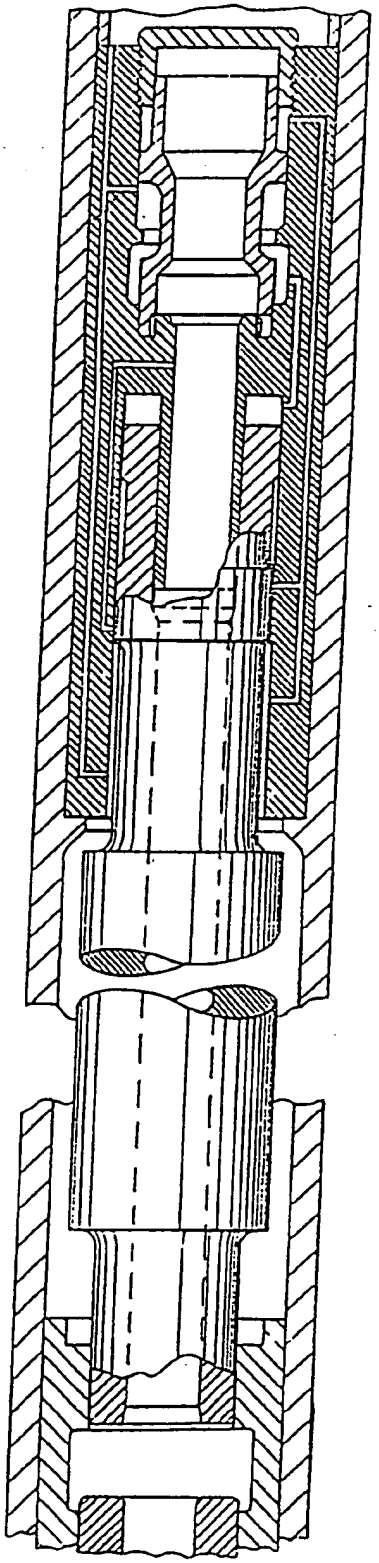


FIG 2



SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00490

I. CLASSIFICATI N OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: E 21 B 4/14, B 25 D 9/16

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	E 21 B; B 25 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	WO, A1, 8900638 (ATLAS COPCO AKTIEBOLAG) 26 January 1989, see figure 2, details 14, 15, 41 and page 4 last paragraph --	1-3
Y	DE, C2, 3343565 (ING. GÜNTER KLEMM, SPEZIALUNTERNEHMEN FÜR BOHRTECHNIK) 14 November 1985, see figure 2 and column 4 last paragraph - page 5 first paragraph --	1-3
A	DE, C2, 2516546 (OSAKEYHTIÖ TAMPELLA AB) 29 July 1982, see the whole document --	1-3

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19th February 1991	1991 -02- 20
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Christer Bäcknert

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III. D CUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECC ND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 90/00490

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 91-01-31
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